The Darwin Roadmap

Session 100
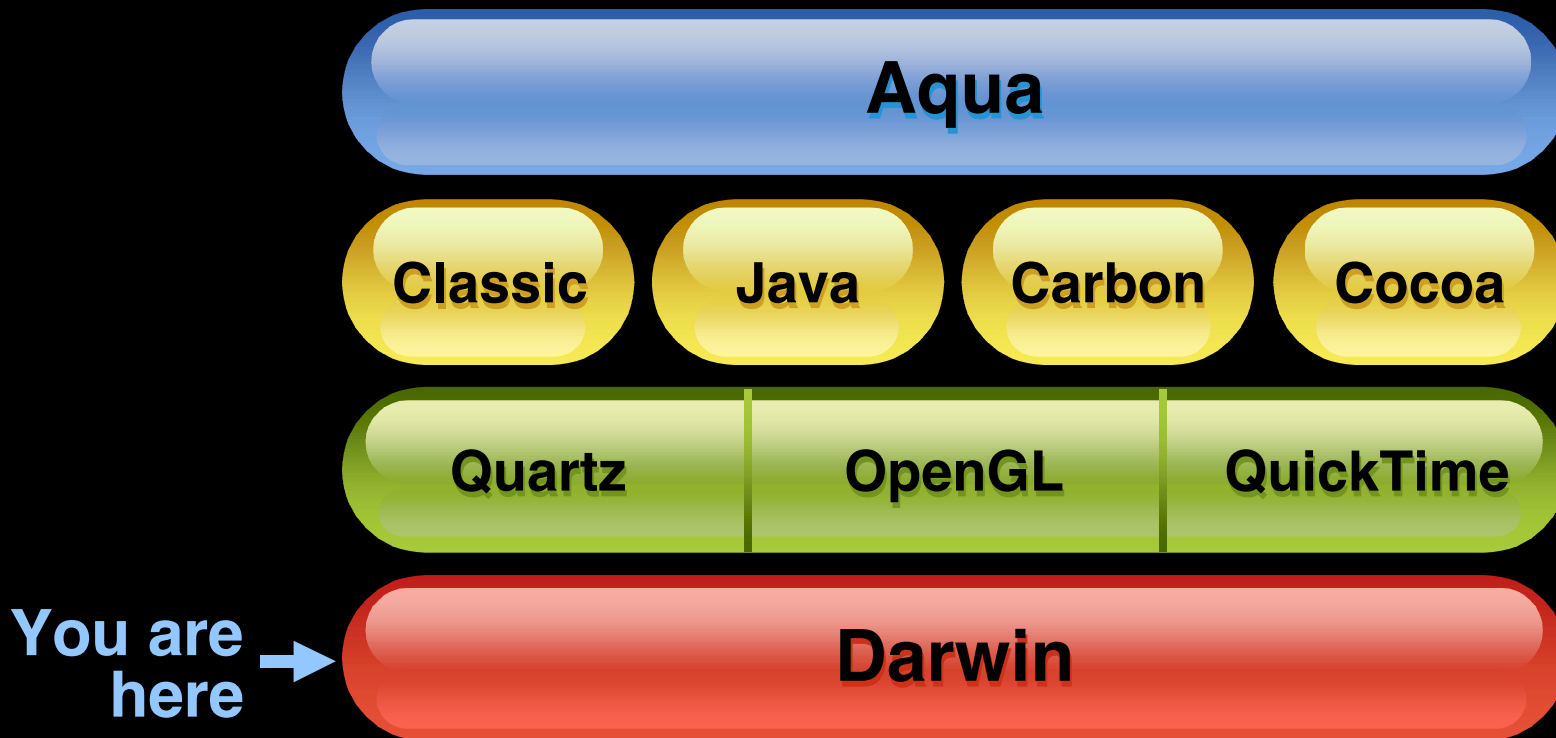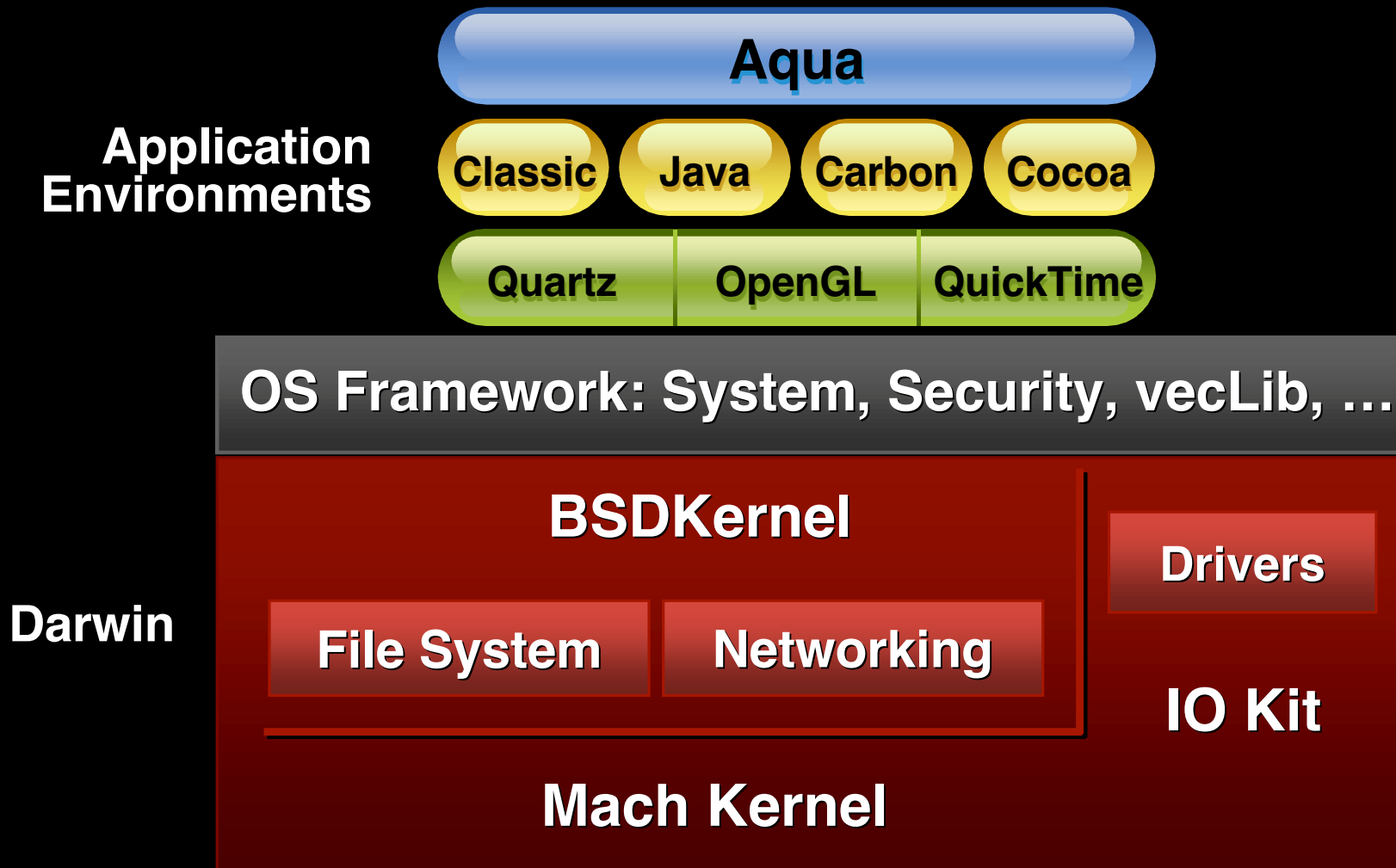
The Darwin Roadmap

Brett R. Halle
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Mac OS X Architecture

Aqua

Classic **Java** **Carbon** **Cocoa**

Quartz **OpenGL** **QuickTime**

You are here → **Darwin**

Darwin/Core OS

Aqua

Application Environments

Classic | Java | Carbon | Cocoa

Quartz | OpenGL | QuickTime

OS Framework: System, Security, vecLib, …

Darwin

BSDKernel

Drivers

File System | Networking

IO Kit

Mach Kernel

What Is the Core OS?

Mach Kernel

- Manages processor and memory resources

- Message-based architecture (IPC/RPC)

- Policy neutral

- All process models are built on Mach primitives
  - Tasks and Threads

- All memory management is built on Mach primitives
  - VMObjects, virtual memory, paging

- Kernel-to-User and User-to-User communication is built on Mach primitives
  - IPC and RPC, "ports"

BSD Kernel

- Based on BSD 4.4-lite plus tight integration w/Mach and IO Kit

- Process model
  - Env variables, signals

- Security
  - Users, file system

- Provides "OS Personality" APIs and Services
  - Process model
  - Basic security policy
  - File system architecture
  - Networking architecture

What's New?

- New panic handling . integrates with Crash Catcher
- Processor scheduling improvements
  - Cross processor pre-emption
  - Processor affinity
- VM improvements
  - Adaptive application profile
  - Working set cache
- pthreads: per-thread signals and additional APIs

Developing in the Kernel . . .

- IO Kit is a well-defined environment and we've worked hard to ensure forward compatibility

- Anywhere else, on the other hand . . .

  - Develop at your own risk!

  - In-kernel APIs will change!!

    - We will be working on new in-kernel APIs in future versions of Mac OS X which will be more forward compatible

  - We advise against it for now!!!

    - If you absolutely have to, be sure to work closely with World Wide Developer Relations

Roadmap

107 The Darwin Kernel

Civic
Wed., 9:00am

108 Managing Kernel Extensions

Civic
Wed., 10:30am

**112 Writing Threaded Apps
on Mac OS X**

Room J
Thurs., 9:00am

IO Kit

- Object-oriented framework for easy development of device drivers

- Provides common kernel services for I/O
  - Driver matching
  - Power management

- Protocol specifics are in Families

- Device specifics are in Drivers

New IO Kit Services

- Enhanced KEXT management
- GCC3 transition
- Power Management
  - AC vs. battery settings
  - UPS support
- HID Manager
  - Mice integrated into HID
- Headless booting support
- New PC-Card UI

Roadmap

108 Managing Kernel Extensions

Civic
Wed., 10:30am

101 FireWire Overview

Room A1
Mon., 3:30pm

115 FireWire in Depth

Civic
Thurs., 3:30pm

116 USB in Depth

Civic
Thurs., 5:00pm

File Systems

OS Framework

BSDKernel

File System | Networking

Drivers

IO Kit

Mach Kernel

- Sub-system of BSD Kernel architecture
- Enhanced VFS design
  - POSIX++ interface
  - Layered architecture (stackable)

- Can support numerous file system types
  - HFS, UFS, ISO 9660, FAT, AFP, NFS, WebDAV, UDF, AFS, etc.
- UTF-8 interfaces
- No specific file system affinity
- Enforces file security policy
  - Users, groups, access control

What's New?

- HFS+ supports up to 15TB file systems
- WebDAV: performance and authentication
- SAMBA file sharing part of desktop system
- SMB browsing and authentication
- Quotas
- Automounting of AppleShare and SMB volumes
- UDF R/W support
- Async mounting of remote file systems

Networking

OS Framework
BSDKernel
Drivers
File System | Networking
IO Kit
Mach Kernel

- Sub-system of BSD Kernel architecture
- BSD 4.4-lite TCP/IP Stack (sync'd with FreeBSD 4.4)
  - Socket APIs

- Key features:
  - IPv4 Multi-homing
  - Full IPv4 routing
  - Firewall and NAT mechanisms
  - IPv6 and IPSec
- Auto configuration

What's New?

- Sync'd with FreeBSD 4.4
    - Updated NAT, Firewall subsystems
- IPv6: It's here . . .
- IPSec
- PPTP: PPP support and new client app
- Transition to LDAP
- SNMP
- NetBoot 2.0

Rendezvous

- Ease of AppleTalk brought to TCP/IP
    - Open standards-based solution
    - Zero configuration networking
    - Multicast DNS
    - Service Registration and Discovery
    - Scalability
    - Examples:
        - Peer-to-peer laptops
        - Headless devices
        - The next cool thing . . .

Demo

Roadmap

803 Mac OS X Networking Overview	Room A2 **Tue., 9:00am**	
809 Advanced Mac OS X Networking	Room C **Thurs., 9:00am**	
811 Zero Configuration Networking	Room J **Thurs., 2:00pm**	
813 Directory Services	Room C **Thurs., 3:30pm**	
FF012 Core OS Networking	Room J1 **Fri., 2:00pm**	

BSD Application Environment

- Application level APIs, services, and tools
- "The Power of UNIX"

- Command line/shells
- Network client tools
  - ssh, finger, ftp
- File tools
  - cp, ls, mkdir
- System tools
  - ps, kill, top, shutdown
- System services
  - LDAP, DNS/BIND, NTP, syslog, Apache

Inbox

Delete   Reply   Reply All   Forward   Compose   Mailbox   Get Mail

32 messages

	From	Subject
	Tim	An Update...
	Diana	Urlaubsgrüße
	Melissa	Weekend Plans

Lieber Axel,

Grüße aus Thailand! Heute standen eine Bootsfahrt und Tauchen auf dem Programm. Das Wasser ist warm, und die Menschen sind sehr freundlich. Bis bald!
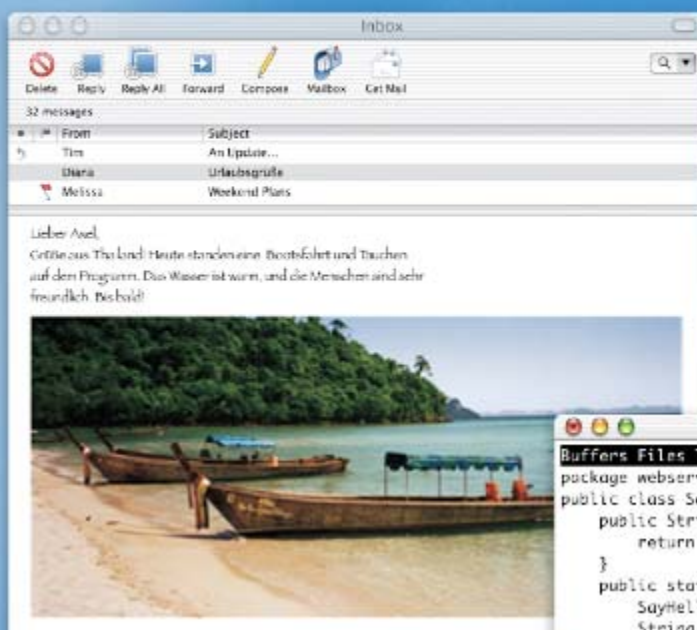
/usr/bin/login (ttyp1)

```
Processes: 44 total, 3 running, 41 sleeping... 118 threads      09:09:39
Load Avg: 1.40, 1.04, 0.86    CPU usage: 82.0% user, 18.0% sys, 0.0% idle
SharedLibs: num = 104, resident = 23.7M code, 1.69M data, 5.91M LinkEdit
MemRegions: num = 3552, resident = 101M + 7.18M private, 107M shared
PhysMem: 48.1M wired, 71.6M active, 229M inactive, 349M used, 163M free
VM: 1.66G + 48.1M   20277(0) pageins, 13699(0) pageouts

PID COMMAND     %CPU  TIME    #TH #PRTS #MREGS RPRVT  RSHRD  RSIZE  VSIZE
984 top         6.7%  0:12.40  1   14    14    240K   308K   480K   1.37M
980 iTunes      0.0%  0:26.04  8   134   184   6.48M  9.92M  10.4M  71.1M
962 tcsh        0.0%  0:00.17  1   24    16    504K   636K   968K   5.78M
953 Microsoft   0.0%
952 Netscape 6  53.0%
951 Adobe Phot  0.7%
950 perl        0.7%
946 apache      0.7%
945 XDarwinSta  0.0%
944 xinit       0.0%
```

80×27

```
dselect - inspection of package states (avail., priority)       ve
EIOM Pri Section  Package     Inst.ver    Avail.ver   Description
     ----- Up-to-date Optional packages -----
     --- Up-to-date Optional packages in section gnome ---
*** Opt gnome    glib        1.2.10-3    1.2.10-3    Common C ro
      me       gnome-libs  1.4.1.1-4   1.4.1.1-4   Base librar
      me       gtk+        1.2.10-3    1.2.10-3    The Gimp To
      me       orbit       0.5.8-3     0.5.8-3     The CORBA O
     Up-to-date Optional packages in section graphics ---
   phics gimp       1.2.2-4     1.2.2-4     The GNU Ima
   phics imlib      1.9.10-2    1.9.10-2    General imag
   phics libjpeg    6b-2        6b-2        JPEG image
   phics libpng     1.0.12-2    1.0.12-2    PNG image f
   phics libtiff    3.5.5-5     3.5.5-5     TIFF image
    installed ; install (was: install). Optional
 NU Image
```

emacs - /usr/bin/ssh (ttyp2)

Buffers Files Tools Edit Search Mule Java Help

```java
package webservices;
public class SayHello {
    public String greet(String name) {
        return "Hello " + name;
    }
    public static void main(String[] args) {
        SayHello greeter = new SayHello();
        String name = (args.length > 0) ? args[0] : "World";
        System.out.println("Result = "+greeter.greet(name));
    }
}
```

```
----:---F1  SayHello.java     (Java)--L11--All----------
<dd:service xmlns:dd="http://xml.apache.org/xml-soap/deployment"
    id="urn:greetings">
<dd:provider type="java"
             scope="Application"
             methods="greet">
    <dd:java class="webservices.SayHello"
             static="false" />
</dd:provider>
<dd:faultListener>
 org.apache.soap.server.DOMFaultListener
</dd:faultListener>
<dd:mappings />
</dd:service>
----:---F1  SayHello.xml      (SGML)--L1--Top----------
Initializing jdb...
> run
run webservices.SayHello "Mac OS X"
>
VM Started: Result = Hello Mac OS X
----:**-F1  *gud-webservices.SayHello*    (Debugger:exit)--L5--Top----------
```

iTunes

Search

Source	Song	Time	Genre
Library	Blue Hotel	3:13	Rock
iPod	Somebody's Crying	2:48	Rock
Radio Tuner	Put That Record Back On	7:01	Electron
Rock & Roll	Romeo & Juliet	4:56	Jazz
Summer Party	When We Collide	4:22	-
Romantic	Only Love	3:52	-
	When We Collide	4:22	-
	Only Love	3:52	-
	When We Collide	4:22	-
	Only Love	3:52	-
	Ascension "Someone" (Slacker Mix)	6:59	Electron
	Voyage "Motion"	12:04	Electron

134 songs, 9:30:14 total time, 652 MB

---

tp://www

tes: The   lor picker modules are
   can't be

s: Uses   usual libtool fix. Ne
ome Make   catalogs in the right

of gimp

- Apple System Profiler
- Applet Launcher
- ColorSync Utility
- Console
- CPU Monitor
- DigitalColor Meter
- Directory Setup
- Disk Copy
- Disk Utility
- Display Calibrator
- Grab
- Installer
- Java Web Start
- Key Caps
- Keychain Access
- NetInfo Manager
- Network Utility
- Print Center
- ProcessViewer
- Terminal

Show In Finder

What's New?

- Sync up with FreeBSD 4.4 (libc, curses, etc.)
- BASH now /bin/sh
- Python
- BSD SDK: openssl, libcurl, libedit, libbzip, etc.
- Latest versions of Apache, perl, emacs, etc.
- Lots of new and updated man pages
- PAM integrated into BSD tools and with the Security Framework
- Additional "portability" APIs, libraries, and services

Command Line Access . . . .

- Full UTF-8 support
- ATSUI rendering
- X-term based emulation
- Split-window scroll back buffer
- Improved preferences

Roadmap

104 Mac OS X Overview for UNIX Developers	Civic	**Tue., 3:30pm**
105 Porting UNIX Apps to Mac OS X	Civic	**Tue., 5:00pm**

Security

OS Framework: Security	
BSDKernel	**Drivers**
File System · Networking	
	IO Kit
Mach Kernel	
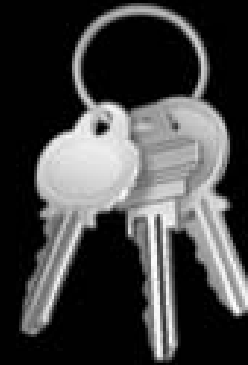
- Configurable
- Standards based
- Libraries and services to support development of security capable applications

- Keychain
- Encrypted disk images
- Pluggable authentication
  - Kerberos
  - Smart cards
- Certificate management
- Secure Transport

New Security Services

- Kerberos
  - KfM 4.5 w/Kerberos v4 and v5 support
  - Integrated into Login, Mail, AppleShare, . . .
- PAM and the Security Framework
- CDSA vs. OpenSSL
- Certificate Management: X.509 and more

Certificate Management . . .
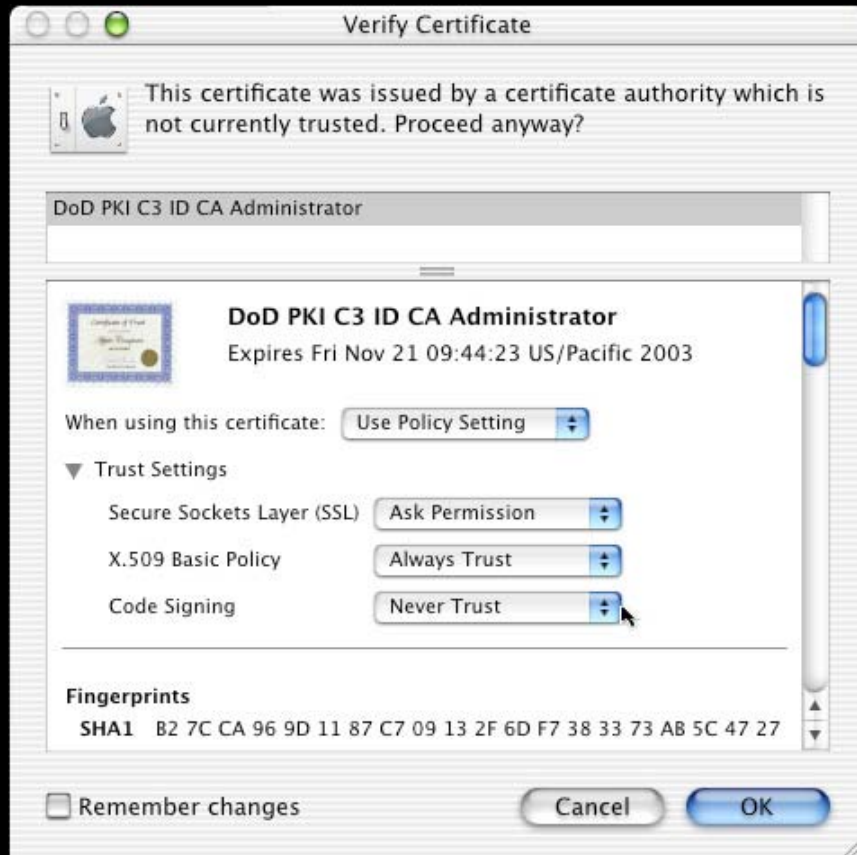
- UI available from Carbon and Cocoa

- Lets users make trust decisions for specific policies

Packaging Your Products . . .

- Remember, Mac OS X is a multi-user operating system
  - Make sure installed apps work with different logged in users
  - File ownership is important
  - Permissions are even more important
    - World writable files are a security hole
- Avoid setuid applications
  - There are other options!

Roadmap

**110 Security:
Authorization in Mac OS X**

Civic
Wed., 2:00pm

**113 Security:
CDSA and Secure Transport**

Civic
Thurs., 9:00am

**114 Security:
Certificates in Mac OS X**

Civic
Thurs., 10:30am

814 Kerberos in Mac OS X

Room C
Thurs., 5:00pm

FF006 Security Feedback Forum

Room J1
Thurs., 2:00pm

Vector/Math Libraries

OS Framework: vecLib, …

BSDKernel

Drivers

File System   Networking

IO Kit

Mach Kernel

- Highly tuned vector (AltiVec) and scalar math libraries

- vDSP: fast digital signal processing functions

- vBLAS: vector Basic Linear Algebra Subroutines, including matrix operations

- vMathLib, vectorOps, vBasicOps and vBigNum

What's New?

- Libm (MathLib v5): IEEE-754 and C99 compliant optimized math library

- Basic Linear Algebra Subroutines (BLAS)

  - Double and single precision, real and complex data types

- vDSP: Double precision FFTs including 2D FFTs, as well as single precision DSP functions

Performance of Real 2D-FFT

Mac OS X vDSP on 1GHz vs. LINUX IPP on 2.2 GHZ P4

Smaller figures in *μsec* are better

IPP values: 5.5, 10.5, 17, 34.3, 59.9

vDSP values: 5.9, 7.4, 13.4, 19.1, 38.7

X-axis (Node size): 256 (16 x 16), 512 (16 x 32), 1024 (32 x 32), 2048 (32 x 64), 4096 (64 x 64)

Y-axis: μs
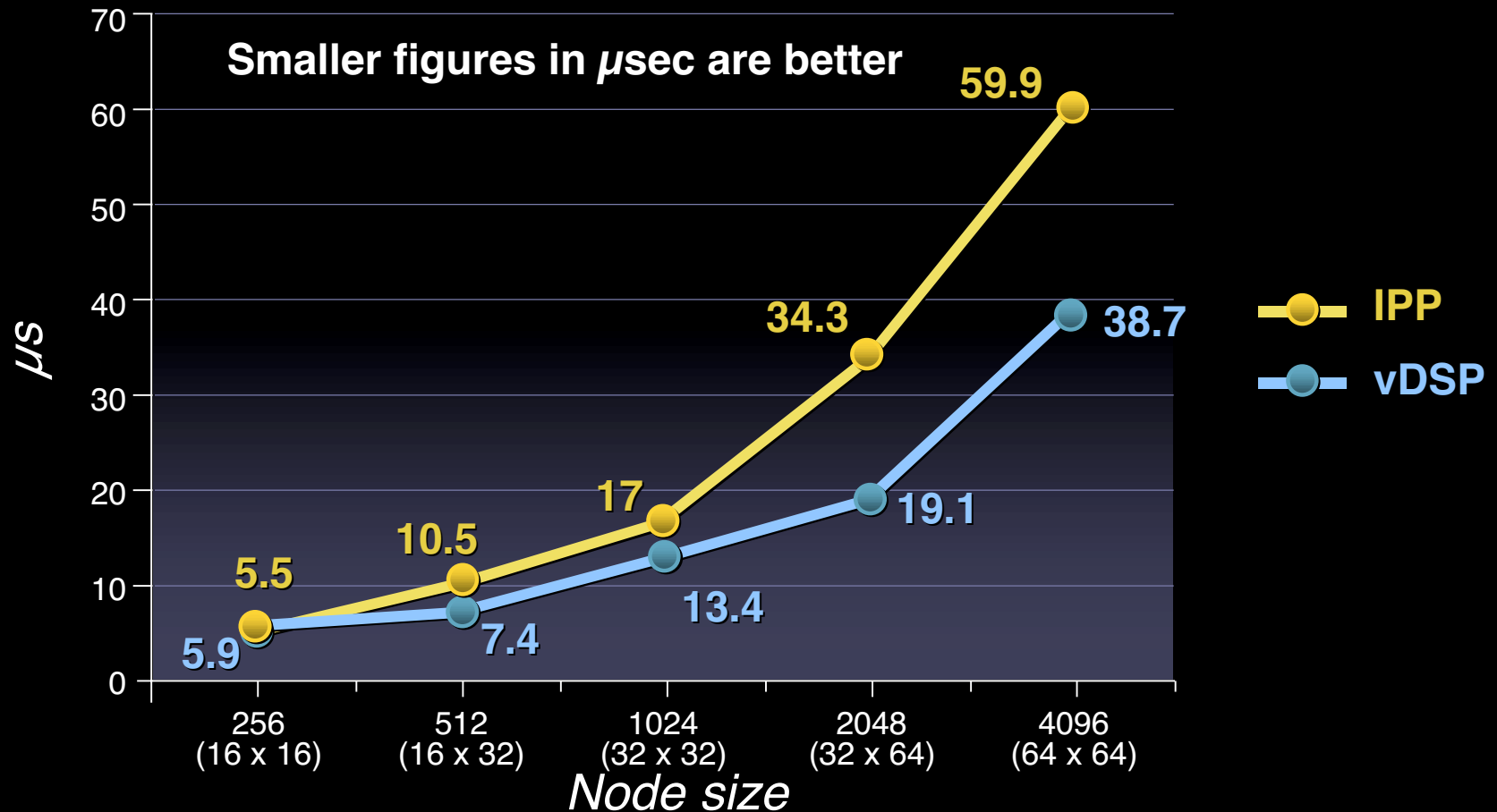
Roadmap

102 Performance Optimization With Velocity Engine

Room J
Tue., 9:00am

Darwin Open Source

OS Framework

BSDKernel

Drivers

File System **Networking**

IO Kit

Mach Kernel
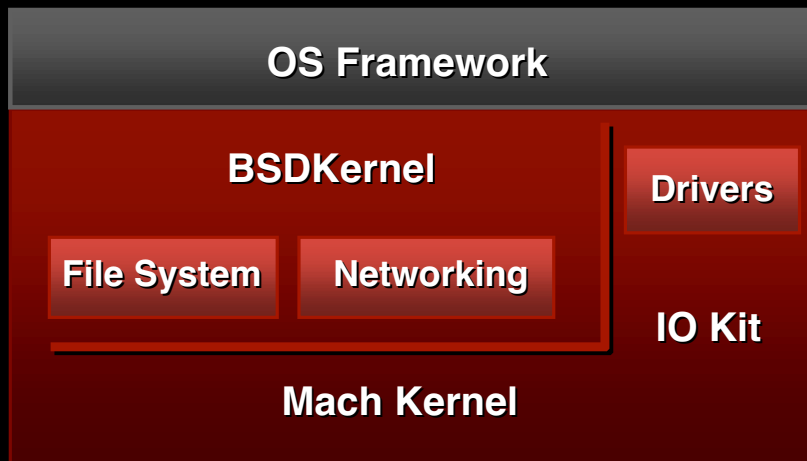
- Apple is serious about open source
- Darwin is the Core OS of Mac OS X

- Open source projects:
  - Darwin
  - Darwin Streaming Server
  - OpenPlay
  - CDSA
  - HeaderDoc
- Come join us!

New Open Source Initiatives

- opendarwin.org
  - Easier to participate in open source projects
  - Community driven
- New projects:
  - Open Directory
  - CUPS
- Great progress by the open source community . . .

Roadmap

103 Open Source, Apple, and You

Civic
Tue., 2:00pm

A Few Last Thoughts . . .

- Develop to the highest level of abstraction
- Carbon, Cocoa, et al are built on top of these foundations . . .
- Performance is even more important on a modern core
- Rendezvous is really cool
- Always think about security
- Come be part of the Darwin community

Roadmap

906 Developing for Performance

Hall 2
Fri., 9:00am

FF002 Darwin Feedback Forum

Room J1
Wed., 3:30pm

FF006 Security Feedback Forum

Room J1
Thurs., 2:00pm

FF012 Core OS Networking Feedback Forum

Room J1
Fri., 2:00pm

Who to Contact

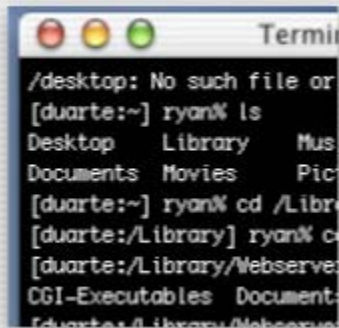**Brett R. Halle**
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brett@apple.com

Jason Yeo
Cool Dude
jason@apple.com

http://developer.apple.com/wwdc2002/urls.html